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SHORE-FLY (DIPTERA: EPHYDRIDAE) COMMUNITY STRUCTURE IN SELECTED TERRESTRIAL GRASS HABITATS OF OHIO AND ILLINOIS

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Abstract.—The composition of shore-fly (Diptera: Ephydridae) populations is reported from terrestrial habitats in Illinois for the first time. The consistent collection of ephydrid species in Ohio and Illinois localities substantiates the wider ecological distribution in nearctic terrestrial grass habitats. During spring, the collection of gravid *Leptopsilopa atrimana* (Loew), *Philygria debilis* (Loew), *Hyadina albovenosa* Coquillet, and *Nostima scutellaris* Cresson suggests that these species have encountered physical and biological conditions satisfying minimum reproductive requirements in mowed terrestrial grasslands. Quantitative parameters that include species diversity (H'), evenness (J'), richness (s) and relative abundance (RA), were calculated for several terrestrial grass habitats in Ohio and Illinois. The high inter- and intra-state indices of similarity (I) suggests that these populations are comparable.

Key Words: Diptera, Ephydridae, terrestrial, Sorenson Index

The Ephydridae are one of the most diverse families of cyclorraphous Diptera. Of the 404 nearctic shore-fly species (Deonier 1979), most are semi-aquatic as adults and aquatic as immatures. Dahl's (1959) investigation of Scandinavian Ephydridae represents the first aquatic and marine study dealing with distributional, behavioral, and ecological requirements. Similar investigations have been completed in localized nearctic wetland habitats (Deonier 1965, Scheiring and Foote 1973, Regensburg 1976, Deonier and Regensburg 1978, Steinly 1979, Steinly and Deonier 1980, Zack 1979, 1983, Todd and Foote 1987). These wetland habitats were distinguished by vegetation types and/or substrate constitution in various physiographic regions.

Not all shore-fly habitats occur in wetlands, however. Latreille (1805), Schiner (1864), Rapp (1942), Sturtevant and Wheeler (1954), and Dahl (1959) reported a few distinctly xerophilous ephydrid species. Recently, large numbers of shore flies were collected from dry, palearctic habitats dominated by grasses (Pesková 1978, Bährmann 1978). In a discussion of the life history of *Leptopsilopa atrimana* (Loew), Steinly and Runyan (1979) reported 14 species of Ephydridae collected over a nearctic terrestrial grass lawn. Later, Steinly (1984) compared shore-fly diversity, evenness, richness, and relative abundance values of selected aquatic and terrestrial habitats in Ohio. The quantitative parameters, shore-fly seasonal persistence, and the observed physical, biological, and community differences supported the designation of terrestrial grass as an ephydrid habitat (Steinly 1984).

In this paper, evidence is presented to substantiate the wider ecological distribu-

tion of shore flies in terrestrial habitats. Shore-fly species diversity, evenness, relative abundance, richness, and similarity values in Illinois and Ohio terrestrial grass habitats are compared. Also, quantitative comparisons are made between terrestrial grassland habitats located within each state.

Description of Study Areas

In Oxford, Ohio (Butler County), sampling was initiated over terrestrial grass-dominated lawns and athletic fields on the campus of Miami University. Two grass lawns were also sampled at the Mallot (Steinly and Runyan 1979, Steinly 1984) and Pohl properties 4.0 km and 4.5 km north of Oxford, respectively. Vascular plant species commonly collected from these rural lawns included: *Festuca elatior* Linnaeus, *Cyperus esculentis* Linnaeus, *Digitoria sanguinalis* (Linnaeus) Scopoli, *Setaria faberi* Herrman, *S. lutescens* (Weigel) Hubbard, *Medicago lupulina* Linnaeus, *Muhlenbergia schreberi* J. Gmelin and *Oxalis* sp. Linnaeus (Steinly 1984).

In Illinois, the grass lawns were located in the cities of Urbana, Champaign (Champaign Co.), and Peoria (Peoria Co.). Plant genera commonly encountered included *Festuca* sp. (Meadow fescue), *Digitoria* sp. (crabgrass) and *Cyperus* sp. (sedge). All collecting sites in Illinois and Ohio were well drained, as sufficient slope prohibited surface accumulation of precipitation. Terrestrial grass habitats in Ohio and Illinois were located 0.5 km from the nearest surface water and were not subject to irrigation. All Illinois grass habitats were infrequently mowed and had substantial accumulations of grass clippings in various stages of decomposition. The Miami University lawns were mowed often and dry clippings were rarely observed.

Materials and Methods

Shore flies were collected with a modified aerial sweep net (Regensburg 1977) from 9 March through 15 May 1980 in Ohio. In Illinois, ephydrid specimens were collected from 27 March through 7 May 1981. Habitats were sampled for the same approximate amount of time per visit. Insect samples in collecting bags were immediately killed with ethyl acetate at the site and field-sorted before returning to the laboratory. Pinned and unpinned ephydrid specimens were identified to species. All specimens were examined to ascertain reproductive condition. Voucher specimens will be deposited in the Illinois Natural History Survey Insect Collection.

The percentage relative abundance (R.A.) of each species was calculated for all grassland localities, and the percentage ranges (Scheiring and Foote 1973, Deonier and Regensburg 1978, Steinly and Deonier 1980, Steinly 1984, 1986) were characterized as follows: 1–2% rare (r), 3–8% occasional (occ), 9–14% common (c), 15–25% abundant (a), and 26–100% very abundant (va).

The Shannon-Wiener diversity index (H′) (Scheiring 1974) was calculated because it incorporates species richness (s) and evenness. Diversity was calculated by: $H' = \Sigma\, p_i \log_{10} p_i$ where p_i is n_i/N, n_i is the number of individuals of the i th species of the habitat being considered and N is the total number of individuals per habitat. Several authors (Wilhm and Dorris 1968, Olive and Dambach 1973) have stated that H′ is essentially dimensionless and usually not affected by sample size (N). Sanders (1968), Pielou (1969), Fager (1972), and Simberloff (1972) demonstrated that this index is sensitive to sample size in many instances. Terrestrial habitats of comparable area were sampled for approximately the same amount of time and probable differences in sample size reflect biological differences among the habitats (Scheiring 1974). Evenness (J′) (Scheiring 1974) was calculated by: $J' = H'/\log_{10} s$ where s is the species richness (species number) per habitat.

The community composition of the Ohio mowed grass localities (unpubl. data) were compared by means of the Sorenson index

Table 1. Relative abundance (R.A.) and species number (N) for the Ephydridae in Ohio terrestrial habitats (spring 1980).

Species of Ephydridae	Mallot's			Pohl's			All Localities Except Mallot's			Combined Data		
	N		R.A.	N		R.A.	N		R.A.	N		R.A.
Allotrichoma simplex (Loew)	1	r	(0.1)	—		—	—		—	1	r	(0.01)
Hyadina albovenosa Coquillet	7	r	(0.9)	5	occ	(4.8)	5	occ	(2.2)	12	r	(1.19)
Hyadina binotata (Cresson)	14	r	(1.8)	5	occ	(4.8)	15	occ	(6.6)	29	occ	(2.9)
Hydrellia formosa Loew	27	occ	(3.5)	—		—	1	r	(0.4)	28	occ	(2.8)
Hydrellia griseola (Fallén)	1	r	(0.1)	—		—	1	r	(0.4	2	r	(0.19)
Hydrellia tibialis Cresson	1	r	(0.1)	—		—	—		—	1	r	(0.01)
Leptopsilopa atrimana (Loew)	723	va	(92.5)	90	va	(87.4)	193	va	(85.0)	916	va	(90.78)
Nostima scutellaris Cresson	2	r	(0.2)	—		—	—		—	2	r	(0.19)
Pelina truncatula Loew	—		—	1	r	(1.0)	1	r	(0.4)	1	r	(0.01)
Philygria debilis (Loew)	5	r	(0.06)	1	r	(1.0)	9	occ	(3.9)	14	r	(1.38)
Scatella stagnalis (Fallén)	1	r	(0.01)	—		—	—		—	1	r	(0.01)
Trimerina madizans (Fallén)	—		—	1	r	(1.0)	1	r	(0.4)	1	r	(0.01)
Typopsilopa atra Loew	—		—	—		—	1	r	(0.4)	1	r	(0.01)
Total =	782			103			227			1009		

of similarity (I) with mowed grass habitats in Illinois. Also, grass habitats within each state were compared with the Sorenson index. The similarity index was calculated with the formula $I = 2C/A + B$, where I is the index of similarity, C is the number of species shared, A is the number of species in habitat A, and B is the number of species in habitat B (Scheiring and Deonier 1979, Steinly 1984). The Sorenson index ranges from 0 when there is no similarity (no species shared) between habitats to 1 when there is complete similarity (all species shared).

Results

At all Illinois localities, the dominant ephydrid species was *Philygria debilis* (Loew) (va) while *Leptopsilopa atrimana* was very abundant only at Champaign (Table 1 and 2). During the spring of 1981 in Illinois, *L. atrimana* number and relative abundance increased slowly while *P. debilis* gradually decreased. *L. atrimana* relative abundance in all Ohio habitats was consistently above 85%. *P. debilis* was rare (r) in the two localities north of Oxford while the species was occasional (occ) in the dryer and more exposed University grass localities.

The examination and dissection of *L. atrimana* (N = 68), *P. debilis* (N = 54), *Nostima scutellaris* Cresson (N = 4) and *Hyadina albovenosa* Coquillet (N = 6) revealed gravid females in Illinois and Ohio grass habitats. Gravid specimens were first discovered in both states during early April.

H', J', and s were lowest for the terrestrial

Table 2. Relative abundance (R.A.) and species number (N) for the Ephydridae (Diptera) in Illinois terrestrial habitats (spring 1981).

Species of Ephydridae	South Farm Urbana			Bradley Park Peoria			West Ells St Champaign			Combined Data		
	N		R.A.	N		R.A.	N		R.A.	N		R.A
Hydrellia formosa	—		—	—		—	1	r	(0.8)	1	r	(0.3)
Hydrellia griseola	—		—	1	r	(0.7)	2	r	(1.7)	3	r	(0.9)
Leptopsilopa atrimana	11	a	(18.9)	12	occ	(8.5)	66	va	(55.0)	89	va	(27.9)
Lytogaster excavata (Sturtevant and Wheeler)	6	c	(10.3)	—		—	2	r	(1.7)	8	occ	(2.5)
Nostima scutellaris	—		—	—		—	2	r	(1.7)	2	r	(0.6)
Philygria debilis	25	va	(43.1)	128	va	(90.8)	46	va	(38.3)	199	va	(62.4)
Scatella stagnalis	14	a	(24.1)	—		—	1	r	(0.8)	15	occ	4.7
Typopsilopa atra	2	occ	(3.4)	—		—	—		—	2	r	(0.6)
Total =	58			141			120			319		

habitat in Peoria (Table 3). In general, however, the Ohio H′, and J′ values were low while richness values were higher than the Illinois habitat values. Comparison of Ohio and Illinois composite H′ and J′ values shows that the Ohio H′ and J′ are approximately two to three times higher than the same parameters in Illinois terrestrial habitats. The relatively high Sorenson Index of similarity (I) (Table 4) suggests the communities within Illinois and Ohio terrestrial habitats were comparable. In Table 4, the high I values generated by comparing habitats within each state suggests these terrestrial habitats have comparable shore-fly communities.

Table 3. Diversity, evenness, and richness values for Ephydridae in terrestrial habitats.

Localities	Diversity (H′)	Evenness (J′)	Richness (s)
South Farm, Urbana	0.60	0.85	5
Bradley Park, Peoria	0.14	0.30	3
West Ells, Champaign	0.43	0.50	7
All Illinois localities composite	0.44	0.49	8
Mallot's 4.0 km north of Oxford	0.17	0.17	10
Pohl's 4.5 km north of Oxford	0.24	0.30	6
All habitats exc. Mallot's	0.28	0.29	9
All Ohio habitats composite	0.20	0.18	13

Discussion

The similarity values generated by comparing grass habitats within each state suggests the intra-state localities have comparable shore-fly populations. Although interstate comparison of the quantitative parameters (H′, J′, and s) suggests the Ohio and Illinois ephydrid communities are distributed and appointed differently within terrestrial grass habitats, the relatively high intra- and interstate similarity indices (I) suggests that these populations are comparable species assemblages. Moreover, the high interstate I value supports the proposed designation of a new terrestrial grass habitat for the Ephydridae (Steinly and Runyan 1979, Steinly 1984).

The interstate variations in locality H′, J′ and s values suggests that the terrestrial hab-

Table 4. Similarity of shore-fly communities in terrestrial grass habitats (Sorenson's Index of Similarity—see text for calculation).

Mallot's—Pohl's, Ohio	0.500
Mallot's—All University habitats, Ohio	0.632
Pohl's—All University habitats, Ohio	0.800
South Farm—Bradley Park, Ill.	0.500
South Farm–Champaign, Ill.	0.667
Bradley Park—Champaign, Ill.	0.600
Ohio—Illinois habitats	0.667

itats in each state have peculiar local physical and biological conditions. Low and high species diversity indices have been associated with habitat physical and biological limiting factors, respectively (Odum 1971). Specifically, species abundance shifts attributed to torrential rainfall, have been recently documented in shore-fly populations (Scheiring and Connell 1988). The high and low relative abundances of *L. atrimana* and *P. debilis*, respectively, in all Ohio localities were not comparable to their relative abundance values in Illinois. In Illinois, the West Ells Street (Champaign Co.) locality had the greatest number of *L. atrimana*. This Illinois locality and the Ohio localities north of Oxford were shaded during the afternoon, sheltered from wind, and had abundant accumulations of grass clippings. In all probability, temperature extremes, exposure to wind, available minimum feeding substrate, and variation in ground-cover density effects species abundance within established shore-fly communities. Additionally, physical constraints may severely limit colonization and/or the utilization of nutrient resources in grass habitats by the Ephydridae. In all probability, grassland habitat colonization by *L. atrimana* and *P. debilis* is dependent on the accumulation and stability of moist decaying vegetation in the microhabitat (Steinly 1984). In vitro, successful *L. atrimana* larval development was dependent on microorganism populations established on the wet surfaces of decaying grass clippings (Steinly and Runyan 1979).

The presence of gravid *L. atrimana*, and *P. debilis* in Ohio and Illinois suggests that minimum reproductive requirements were satisfied in terrestrial grass habitats. Laboratory rearing of *L. atrimana* on wet grass clippings substantiates the probable use of moist microhabitats in habitats traditionally considered terrestrial (Steinly and Runyan 1979, Steinly 1984). Furthermore, a *L. atrimana* larva was field collected from grass clippings by Steinly (1984).

Previously, shore-fly communities in grasslands have been reported from relatively small regions in the Palaearctic (Bährmann 1978, Pesková 1978) and Nearctic (Steinly 1984). The consistent collection of shore flies in terrestrial habitats of Ohio and Illinois and the relative abundance of *P. debilis* and *L. atrimana* demonstrates the wider ecological distribution of ephydrids in nearctic grassland and suggests that shore-fly colonization of terrestrial habitats is not an aberrant phenomenon. Furthermore, ephydrid colonization of terrestrial habitats represents a significant ecological radiation within a trophically diverse family of Diptera.

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